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Measures of

OPERATING EFFICIENCY IN WHOLESALE FOOD WAREHOUSES

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Marketing Research Report No. 399

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Marketing Service
Transportation and Facilities Research Division

PREFACE

This is one in a series of reports looking to greater efficiency in grocery warehousing.

The work on which this report is based is part of a broad program of research aimed at holding down the cost of marketing farm products through the various stages of the marketing system.

This report is concerned with more effective warehouse management; a companion report, "Improved Methods Among Wholesale Food Distributors for Inventory Control, Sales Accounting, and Shipment of Merchandise," Marketing Research Report No. 271, was concerned with warehouse office procedures. Others, concerned with greater efficiencies in handling groceries, were: "Grocery Warehouse Layout and Equipment for Maximum Productivity," MRR No. 348; "Methods of Increasing Productivity in Modern Grocery Warehouses," MRR No. 94; and "Methods of Increasing Labor Productivity in Multistory and Small One-Floor Grocery Warehouses," MRR No. 142.

The facilities and operations of many firms were studied in this research. Special credit is due Giant Food Stores, Inc., Washington, D. C., and Super Valu Stores, Inc., Minneapolis, Minn., for their cooperation. Charles Crossed, management analyst, and Arnold L. Lundquist, marketing specialist, of the Agricultural Marketing Service, assisted in the research on which this report is based. The work was under the general supervision of R. W. Hoecker, Head, Wholesaling and Retailing Section, Transportation and Facilities Research Division.

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Washington, D. C. May 1960

SUMMARY

The management of a modern food warehouse involves organization and direction of scores of men, and stewardship over large investments in plant, equipment, and inventory. Management now requires knowledge not only of physical operations in the warehouse, but also of ways for evaluating and controlling these activities. Efforts to evaluate and control operations are often first steps in improving them. Essential to evaluation and control are records which give management accurate and timely information about the warehouse operation.

A study was made of the records and forms used by leading food distributors in evaluating and controlling their warehouse operations. Included in the study were measures of labor productivity, work quality, and effective plant and equipment use.

Among the more widely used measures of warehouse labor productivity are: (1) Tons handled per man-hour; (2) cases or units handled per man-hour; and (3) the dollar value of merchandise handled per man-hour. Measures of productivity of individual warehousemen and of groups performing particular tasks, such as receiving from railroads or loading trucks, are most often computed in terms of cases handled per man-hour.

Two measures of work quality were studied: The error rate in outgoing merchandise assembled for delivery to retailers, and the amount of merchandise damaged as a result of in-warehouse handling. The study showed that a "sample item check system," in which only a percentage of items are checked, was more effective in controlling quality of order selection than piece counts, and less costly than 100 percent item checking. A sample item check system was particularly advantageous when the warehouse-retail operations were integrated and when selector error rates were low. To help control merchandise damage in the warehouse, records of what was damaged, how damage occurred, and what was recouped were found useful.

Just as rising hourly wages point up the need for effective use of labor, so rising costs and investments in plant and equipment make it necessary for warehouse management to make optimum use of these resources. Among the most useful measures of effective plant and equipment use are: (1) Use of warehouse space, which may be in terms of empty slots or pallets, or inventory carried per 1000 square feet of warehouse space, or annual inventory turnover rates; (2) the operation of rail car and motortruck receiving, which may be in terms of demurrage charges and waiting time for trucks to dock; and (3) the effective use of equipment, in terms of hours of use versus "down" time and the hourly cost of the equipment used, taking into account maintenance and depreciation charges.

MEASURES OF OPERATING EFFICIENCY IN WHOLESALE FOOD WAREHOUSES

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INTRODUCTION

Management of a modern warehouse or wholesale food distribution center is complex. Scores of employees and large investments in plant, equipment, and inventory are involved. Merchandise is handled in ever greater quantities and varieties.

Knowledge of the physical operations in the warehouse and of ways of evaluating and controlling these operations is necessary to the manager as a means of maintaining and improving efficiency. 1/ Evaluation and control require a system of records that provide accurate and timely information about warehouse operations.

There are many kinds of record forms and procedures which can provide management with such information and, hence, with measures of warehouse operation. These are measures of warehouse labor productivity, work quality, and effective use of plant and equipment. This report describes some of these measures which are particularly useful. Other measures, such as cost per ton-mile for merchandise delivery, cost of processing orders through the office, and return on capital investment, are not covered.

This report explains (1) measures which are useful for controlling warehouse operations and some methods for obtaining the information on which they are based; and (2) ways in which warehouse management can make use of these measures to improve operations and hold down warehousing costs. The report is based on studies among leading wholesale food distributors in many States. The studies included discussions and observations of the firms' development and use of measures of labor productivity and performance, and measures of the efficiency with which they were using their equipment and warehousing facilities.

1/ "Controlling" an operation refers to the measuring of performance against predetermined goals and efforts to bring operations in line with such goals.

MEASURES OF WAREHOUSE LABOR PRODUCTIVITY

Labor constitutes the greatest single expense item of wholesale food warehouses, averaging about half of the total warehousing cost. Hence, high labor productivity is an essential part of warehouse operating efficiency. The first steps in achieving high productivity are accurate and timely measures of labor performance.

Ways of Measuring Productivity

Tons handled per man-hour is probably the most widely used measure of efficiency for the overall commodity warehousing operations, such as handling of groceries, produce, frozen foods, and meats. The measure is sometimes used to evaluate the handling of receipts or of shipments, and sometimes of receipts and shipments combined.

Some trade associations and other organizations obtain information on tons per man-hour from member firms and establish a comparative report on tons per man-hour, for circulation among member firms. Reports of this type have contributed to establishing performance standards among firms in the organization and have provided an incentive to increase warehousing efficiency. 2/

Two methods are used for computing tonnage handled per man-hour. The method used by some organizations starts with the total weight of receipts, plus the total weight of merchandise shipped out of the warehouse, divided by total direct labor hours during a given period. The quotient, in pounds, is divided by 2,000 to give the tonnage handled per man-hour. For example, as shown in figure 5, 370 man-hours were utilized to receive 578,974 pounds and to ship 601,610 pounds of groceries. The total weight of merchandise received and shipped, 1,181,184 pounds, divided by 370 direct labor hours, equals 3,192 pounds of groceries handled per man-hour. Dividing 3,192 pounds by 2,000 would equal 1.60 tons of groceries handled per man-hour. Direct labor includes the hours spent in receiving, storing, transporting, selecting, checking, and loading. Time spent in supervision, maintenance, janitor work, recouping damage, price-marking, cigarette stamping, and clerical work is excluded.

Computations by the second method are made in the same manner, except that warehouse man-hours for supervision and all

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2/ Although comparative reports on tons per man-hour have been helpful to the industry, it is difficult to obtain uniform measures from all firms; hence there is a question of comparability in some reports.

warehouse activities are included in warehouse man-hours in computing tons per man-hour. Using the same example shown for the first method, to the 370 direct labor hours there are added 40 hours of supervision, 20 hours of cigarette stamping, 12 hours of price-marking, 10 hours of sweeping, 5 hours of recouping damage, and 2 hours of miscellaneous work in the warehouse, for a total of 459 man-hours. The total weight of merchandise received and shipped, 1,181,184 pounds, divided by 459 man-hours, equals 2,573 pounds per man-hour. Dividing 2,573 pounds by 2,000 equals 1.29 tons per man-hour.

Many of the factors excluded in the first method of computing tonnage handled per man-hour are a part of all warehousing operations. Man-hours utilized in supervision, recouping warehouse damage, janitor work, and maintenance services are required in all warehouses. But such items as cigarette stamping and price-marking are not performed in all warehouses and should be excluded for industry comparisons. When more of the warehousing operations are included in total man-hours, the computation of tons per man-hour is both easier and more meaningful.

Another measure of overall warehouse productivity used by numerous firms is cases handled per man-hour. While it is necessary to have automatic tabulating equipment in the office to obtain the weight information needed for a report on tons per man-hour, information on the number of cases received and cases shipped during a given time can be obtained with manual office procedures.

Cases or units handled per man-hour is also a widely used measure of the productivity of individual warehousemen in unloading rail cars, selecting and checking orders, and loading delivery trucks. The productivity of groups of workers, such as order selectors, checkers, and loaders, also is frequently reported in cases per man-hour. Usually, in these measures, productive and nonproductive time of the men regularly assigned to their respective jobs is used in computing the ratio.

An additional measure of overall warehouse productivity is the dollar value of merchandise handled per man-hour. This measure is used by some firms having manual office procedures. Records of productivity based on tonnage, cases, or units handled are favored over data on dollar value of merchandise handled because (1) the measuring units (weights and cases) remain more constant than dollar values, and (2) a larger segment of the industry maintains records on the basis of tons and cases per man-hour.

Methods of Obtaining Data on Productivity

To have an effective control program for warehouse labor costs it is necessary to establish ways of obtaining the needed

data. The data obtained and methods of collecting them are dependent on the size of the warehousing operation, number of warehouse employees, number of jobs performed by individual employees, and availability or lack of automatic tabulating equipment.

One method for obtaining data on man-hours for various warehousing functions employs a combination timeclock card and time accounting form. This method is good where most of the warehousemen are regularly assigned to the same work and only occasionally and temporarily are assigned elsewhere. A form for use with this method is shown in figure 1. Exceptions to regular job assignments are entered on the back of the form by the foreman. The summary of individual man-hours involves posting the daily man-hours in accordance with each man's regular assignment after subtracting and posting the man-hours of any temporary assignment.

The Daily Warehouse Time Sheet shown in figure 2 is adapted for use in smaller warehouses where it is not practical for each warehouseman to be assigned one job for an entire day, and in larger warehouses for some employees who are assigned to several different jobs during the day. The form is completed by the warehouseman as he transfers from one warehousing job to another, and at the end of each day it is turned in to the warehouse office. Individual daily time sheets are reviewed and approved by the foreman or superintendent to verify general accuracy. Man-hours, as reported on the daily time sheets, are then totaled by adding machine and man-hour totals for each warehouse operation, such as order assembly or car unloading, can be entered on forms used to compute daily warehouse production reports. This method can be used with or without automatic tabulating equipment in the office.

A record of the number of overtime hours, as well as regular hours, worked by different groups of warehousemen and for all warehouse employees has also proved helpful to warehouse management. Overtime pay is usually at the rate of one and one-half times regular pay, and such records are a first step toward holding down the amount of premium wages. As business volume increases and the number of overtime hours rises, the point at which additional personnel should be hired can be determined on the basis of relative costs.

Records of overtime hours also point up the need for a more balanced workload during the week and point out the way to achieve it. Retail supermarket business volume is largest on Friday and Saturday; therefore, most retailers prefer to receive grocery orders during the early part of the week so shelves can be fully stocked for the weekend business. Many wholesale grocers are confronted with a heavy workload during the first three days of the week and a comparatively small workload on Thursday and Friday. If sufficient labor is hired to handle the heavy workload early in the week, a surplus of labor will be available on Thursday and Friday. Sometimes, shifting the day for delivering a relatively few orders and curtailing a few special orders can appreciably improve the week's workload.

(FRONT)

NAME _____ No. _____

Job Code _____ Shift _____ Branch _____

SHIFT	CODE	REG. HRS.	OVERTIME	TOTAL HRS.

Sun	Mon	Tues	Wed	Thurs	Fri	Sat	TOTAL
							Total

Approved	Total	
	Reg.	Overtime

(BACK)

TIME - OTHER THAN REGULAR JOB CODE

101 Supervision								
102 Whse. Office								
103 Receiving								
104 Packing Rm.								
105 Checking								
106 Selecting								
107 Loading								

CODE

First digit - Department

1 - Grocery
2 - Produce
3 - Meat
4 - Frozen Food
5 - Dairy

Second and third digits - Job

01 Supervision	05 Checking	09 Cigarette stamping
02 Whse. office	06 Selecting	10 Driving
03 Receiving	07 Loading	11 Maintenance
04 Packing room	08 Drug pricing	12 Driving

Figure 1.--A combination timeclock card and accounting form for obtaining warehouse man-hours detail.

(FRONT)

DAILY WAREHOUSE TIMESHEET

(To be filled in along with timeclock card)

Name _____ Employee number _____ Shift _____ Date _____

TIME		JOB NO.	JOB DESCRIPTION - (As shown in capital letters on reverse side)	ELAPSED TIME
START	STOP			

(See reverse side for job numbers and description)

Total shift hours _____

_____ _____

Employee signature Approved by

Turn in daily to warehouse office. Use additional forms if necessary.

(BACK)

DAILY WAREHOUSE TIMESHEET

JOB DESCRIPTION AND JOB NUMBER

JOB NO.	
11	RECEIVING - checking, inspecting and signing for inbound merchandise
12	UNLOADING CARS -
13	UNLOADING DELIVERY TRUCKS -
14	PILING INBOUND - merchandise by hand
15	PILING INBOUND - merchandise with forklift
16	FILLING SLOTS -
17	RETURNS - handling store returns
18	DAMAGED - handling damaged warehouse merchandise
31	SELECTING - including checking work done by selector
32	CHECKING - on loading platform only
33	LOADING - loading for store deliveries
51	HOUSEKEEPING - sweeping, trash disposal, painting, etc.
52	MAINTENANCE - repairing, equipment service, etc.
53	MISCELLANEOUS - include description on time sheet

Figure 2.--A daily warehouse time sheet designed for use in smaller warehousing operations.

Some food distributors handling produce as well as groceries have found the produce volume heaviest on Thursday and Friday. They maintain a balanced work crew in groceries and produce by shifting men from one department to the other in accordance with business volume. The number of overtime man-hours when both groceries and produce are handled has, therefore, been reduced, compared with overtime when only groceries are handled.

Many firms have found it advantageous to measure the performance of individual warehousemen, particularly the productivity of each order filler. The method used to obtain data on the number of cases assembled depends on order selection methods used in each company.

When orders are received from the tabulating department and a complete order is assembled by an order selector, the time and piece count can be obtained for each order. With this system, the order selector stamps the top page of the order on a timeclock when starting the order, and again when the order is completely assembled. Also, he puts his initials or clock number on the order. With this information, the elapsed time can be computed for the individual order selector and a daily summary accumulated. In this procedure, time not spent in selecting would not be counted in computing the order selection rate for the individual.

If orders are assembled by warehouse section or by invoice page or groups of pages, the order selector should initial or write his clock number on each invoice page he assembles. A clerk posts the data from invoices onto a daily production worksheet similar to the one shown in figure 3. The worksheets are used to compute daily production in cases per man-hour, and the daily production is posted on a weekly summary sheet (fig. 4). The weekly summary sheet provides a record showing the influence of workload on order filler productivity and furnishing information necessary for action to achieve a more balanced workload. These methods and record forms can be used with either manual procedures or automatic tabulating equipment in the office. Data on the number of selection errors are obtained from records kept by checkers (fig. 6).

Data must be obtained not only on warehouse man-hours for various functions, but also on the volume of merchandise handled. In companies using automatic tabulating equipment in the office, a procedure for obtaining the inbound tonnage is to reproduce one extra card for each lot received, using the reproducing punch. The extra card for each lot received is used to prepare a daily receiving list showing commodity code number, item description, and quantity. The total weight of merchandise received can be extended and totaled from this listing. The weight of merchandise shipped out of the warehouse each day can be obtained directly from the tabulating machine totals on invoice forms or from the trucking department records. Information on the weight of merchandise received and shipped each day can be readily obtained from the tabulating department.

Date 6-17

Daily Production Worksheet

Order selectors

Customer No.	S. Jones		W. West		A. Green		W. Campbell		Total cases	Total cases checked	Errors found
	No. of cases	Errors	No. of cases	Errors	No. of cases	Errors	No. of cases	Errors			
27	132	-	146	-	191	-	-	-	469	227	-
35	167	-	122	-	117	-	-	-	406	219	-
48	110	-	142	-	127	1	-	-	379	186	1
26	162	-	157	-	179	-	88	-	586	284	-
15	149	-	113	-	151	-	137	-	550	271	-
17	117	1	119	-	179	-	125	-	540	254	1
8	135	-	93	-	127	-	87	-	442	231	-
13	207	-	133	-	196	-	117	-	653	339	-
24	96	-	77	-	113	1	93	-	379	187	1
4	111	-	79	-	98	-	129	-	417	215	-
42	99	-	79	-	33	-	47	1	258	139	1
16	36	-	147	-	113	1	124	-	420	206	1
Total cases	1,521	-	1,407	-	1,624	-	947	-	5,499	2,758	-
Total hours	8	-	8	-	8	-	6	-	30	-	-
Cases per hour	190	-	176	-	203	-	158	-	183	-	-
Total	-	1	-	-	-	3	-	1	-	-	5

Figure 3.--A daily production worksheet for order selectors.

WEEKLY ORDER ASSEMBLY SUMMARY SHEET

Name of selector	Item	Mon.	Tues.	Wed.	Thurs.	Fri.	Total this week	Total previous week	Remarks
1. S. Jones	Cases assembled	1,726	1,447	1,521	1,366	1,091	7,151	7,232	Worked in section 2 on Thurs.
	Assembly hours	9	8	8	8	6	39	37	
	Cases/hour	192	181	190	171	182	183	195	
	Errors	3	-	1	1	2	7	11	
	Error rate per 10,000 cases	17	-	7	7	18	10	15	
2. W. West	Cases assembled	1,641	1,371	1,407	1,077	1,240	6,736	7,041	
	Assembly hours	9	8	8	6	8	39	40	
	Cases/hour	182	171	176	180	155	173	176	
	Errors	2	1	-	-	2	5	8	
	Error rate per 10,000 cases	12	7	-	-	16	7	11	
3.									
4.									
5.									
Warehouse total	Cases assembled	13,496	15,071	15,722	13,417	9,764	67,470	69,643	
	Assembly hours	72.25	81.50	81.50	72.00	63.00	370.25	381.75	
	Cases/hour	187	185	193	186	155	182	182	
	Errors	10	22	17	12	11	72	78	
	Error rate per 10,000 cases	7	15	11	9	11	11	11	

Figure 4.--A summary of productivity and accuracy of order selectors by days of the week, and weekly total.

When tabulating equipment is not used, the volume of merchandise received and shipped each day is usually obtained by counting the number of cases received and shipped. The receiving clerk can summarize the number of cases received from receiving documents. The shipping clerk can obtain the number of cases shipped, either from customer invoices or by case counts made by order checkers.

Overall warehouse productivity can then be measured on the basis of number of cases, or the cases can be converted to either pounds or tonnage handled per man-hour. In the warehouses studied the average case weight of groceries ranged from 30 to 35 pounds.

Some of the companies studied use a form similar to the one shown in figure 5 for accumulating weekly warehouse man-hours by warehouse jobs or functions. With this form, it is possible to compute productivity in the warehouse and to maintain a record of warehouse performance for any period of time desired. Many companies compute warehouse production each week and combine reports every 4 weeks for a period or monthly report. The form contains all the information necessary to compare productivity with that of other firms.

MEASURES OF WORK QUALITY

Management in wholesale food distributing firms is concerned not only with high levels of labor productivity, but also with high standards of quality in the work done. In plants where products are manufactured, quality control is usually an integral part of the operation: Products coming off the assembly line are checked to see if they measure up to specified standards. The quality of work done by warehousemen in food distribution firms can also be measured. Probably the two most important measures of work quality are: The error rate in outgoing merchandise assembled for delivery to the retailer, and the amount of merchandise damaged as a result of in-warehouse handling.

In warehouses studied, the task of catching and controlling errors in warehousemen's work took many man-hours. Performing this task more efficiently means dollar savings in labor costs as well as fewer errors. This part of the report presents procedures for measuring and increasing the efficiency of the checking or "quality control" operation.

Controlling Quality of Work in Order Selection

One of the important operations in grocery warehousing is the checking of merchandise before delivery to the retail stores. Checking is important for two reasons: First, the retailer probably needs the merchandise he ordered and a failure to receive the items may mean loss of sales and consumer patronage; second,

A.B.C. Grocery Distribution Warehouse

Warehouse Labor Distribution Form--Week Ending 5 p.m. Date 6/4/60

Name	Receiving	Unloading cars	Unloading trucks	Piling inbound	Restocking returns	Order assembly	Checking	Loading	Restocking assembly line	Restocking packing room	Stamping cigarettes	Price marking	Recouping damage	Scrubbing sweeping	Misc. maintenance	Inventory	Supervision	Total hours
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
J. Smith	20	20										2			1			43
T. Brown		40	1										2					43
A. Jones				32					10						1			43
S. Jones						40												40
W. West					10	31												41
A. Green						22				10	10							42
G. Johnson							30					10						40
H. Johnson								42										42
T. French								20			10		3	10				43
W. Campbell						42												42
J. Super																	40	40
Total job hours	20	60	1	32	10	135	30	62	10	10	20	12	5	10	2		40	459
Job No. Department	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	

Inbound analysis				Outbound analysis				Out and in analysis			
Hours	123	Pounds	579,274	Hours	247	Pounds	601,910	Hours	370	Pounds	1,181,184
Tons	290	T.P.M.H.	2.36	Tons	301	T.P.M.H.	1.22	Tons	591	T.P.M.H.	1.60

Previous totals:		This wk.	To date	Previous totals:		This wk.	To date	Previous totals:		This wk.	To date
Hours	1,859	123	1,982	Hours	3,876	247	4,123	Hours	5,735	370	6,105
Tons	4,481	290	4,771	Tons	4,596	301	4,897	Tons	9,077	590	9,667
T.P.M.H.	2.41	2.36	2.41	T.P.M.H.	1.19	1.22	1.19	T.P.M.H.	1.58	1.50	1.58

Figure 5.--A weekly warehouse labor distribution and productivity form being cumulated for a year.

errors in the kinds or quantities of merchandise shipped mean errors in customer billing, with attendant loss to the warehouse or retailer. Since some mistakes in order selection are inevitable, checking is necessary to hold errors down to acceptable levels; warehouse checking is the means of maintaining the "quality" of an order selection operation.

Acceptable Error Rates in Outgoing Merchandise.--The acceptable error rate for outgoing merchandise varied widely among warehouses studied. Error rates can properly vary among different kinds of warehousing-retailer operations. For example, errors in merchandise shipped to a small store receiving one delivery a week are likely to be more serious for the retailer than similar errors to a large supermarket receiving several deliveries a week. Again, errors in outgoing loads may be more costly for a wholesaler serving independent retailers than for a chain store organization.

How does warehouse management decide what error rate to permit in outgoing merchandise? What error rate should be set as a goal? Among leading supermarket organizations studied, error rates of .1 to .3 percent on outgoing merchandise were considered acceptable; that is, in a truckload of 1,000 cases, 1 to 3 cases might be in error. Among smaller wholesaler-retailer organizations, similar goals were found, but actual operation fell short of the objectives--particularly where piece count checking was used.

Two ideas about checking have guided warehouse management in deciding what error rate to permit. The most prevalent idea was that a checking system is supposed to catch and correct all selector errors. On reflection, of course, warehouse management recognized that some errors persist through any system of checking, and the cost of trying to obtain virtual error-free deliveries may be excessive. The second idea, favored by some leading chain-store organizations, was that checking was designed to insure integrity in warehouse selection and in retail reporting of shipments, and to obtain an acceptable error rate at a minimum checking cost.

Checking at the warehouse serves several purposes, all connected with the quality of order selection. Among the purposes a checking system should serve are these: (1) Keeping warehouse management apprised of the kind and quantity of errors being made; (2) making order selectors aware that their work is being checked and that careless selection will not be tolerated; (3) making retail store managers aware that warehouse management is controlling the quality of order selection and, hence, will know if unjust claims for shortages are being made; and (4) reducing the number of errors in the outgoing merchandise by finding mistakes made in selection and correcting them. In general, an effective system, then, is one that holds down selection errors and assures an error rate in outgoing merchandise acceptable for the individual warehouse, at a minimum cost.

Alternative Systems of Warehouse Checking.--What system of checking will give optimum control over errors in outgoing merchandise at minimum cost? There are four basic systems of checking now in use:

1. A piece count of all cases selected for each order.--If the total number of pieces selected is the same as the number called for in the order, the work is assumed to be acceptable and the order is shipped. If the totals are different, the checker is supposed to make a recheck by item description, to determine what error has been made and to correct it.

The disadvantage of this system is that selection errors of substitution (approximately 60 percent of all errors made by selectors are of this kind, rather than errors of count) are seldom uncovered by piece count checking unless a mistake has been made also in the number of cases pulled. Moreover, in most warehouses, piece count checking is done without maintaining a record of the number of errors found, or of the selectors responsible for the errors. Hence, piece count checking does not contribute much to improved selection, nor does it catch and correct the major portion of selector errors. An accurate measure of errors in outgoing merchandise cannot be obtained under this system. The principal advantages of piece count checking are speed and low cost, coupled with a prevailing idea that selectors' work is being checked.

2. A 100 percent item description check.--Under this system, each item on all orders is checked for correct description, size, and pack, as well as number of cases. If an error is found, it is corrected, and the order is then ready for shipment. The disadvantage of this system is that it is relatively slow and costly. The advantages are that it provides a high degree of control over selection quality and, by catching and correcting most errors, assures a low error rate in outgoing merchandise.

3. A spot check of items by description.--This system of checking has many variations, but generally is a haphazard pulling out of orders to be checked on a 100 percent item description basis. Sometimes orders of problem stores or problem selectors are checked more thoroughly than others, but in most instances the decision as to which orders to check is left up to the checkers. The disadvantages of this system are similar to those of the piece count. Many errors are not caught and corrected. More important, there is no assurance that the orders checked are like those not checked and, hence, no assurance as to the number of errors in the shipments made. The advantages are that it is simple and low in cost, and gives the feeling that selectors' work is being checked.

4. A sample item check.--This is a controlled and systematic checking of a selected number of cases and orders. Sample checking is based on prescribed statistical formulas and, hence, provides statistical assurance of selection quality. The sample of

cases and orders checked is designed to assure warehouse management that the error rate found in the orders checked is about the same as in the orders not checked. Thus, a sample item check can assure management of order selection within known limits of accuracy at less cost and in less time than a 100 percent item description check. The disadvantage of a sample item check is that it permits more errors in outgoing merchandise than the 100 percent item check.

Determining the Appropriate Checking System.--Since neither a piece count alone nor a spot check offers warehouse management adequate control of the quality of order selection, and neither can tell management what the actual error rate is in outgoing merchandise, the question is whether a "100 percent item check" or a "sample item check" should be used. The considerations involved in answering this question are (1) the relationship between the retailer and the warehouse or wholesale distributor, (2) the size of the retail order and the frequency of delivery, (3) the order selecting method as it affects checking time, and (4) the actual error rate of the selectors.

A sample item check system allows more errors in outgoing merchandise than a system where every item is checked, and the saving in checking costs needs to be weighed against other costs. These "other costs" vary in different organizations. Among wholesalers serving small independent retailers, the driver and the retailer usually check every item in the small order and both shortages and overages are caught and corrected. 3/ However, catching an error here may still leave the retailer without some needed item until the next delivery. In chainstore organizations, a trailer of merchandise is often left at the store and the manager's report on errors is accepted. Store managers tend to report shortages more frequently than overages (studies in several warehouses indicate that, of the errors found by checkers, 55 percent are shortages and 45 percent overages). Thus, while the warehouse is required to make up short orders (or give the store credit for the merchandise,) overages which are not reported cause some loss at the warehouse level. In a chain operation, this probably need not be reckoned as a company loss, since the merchandise will be sold at retail and reflected in the store's

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3/ There is a question whether checking is necessary at both wholesale and retail levels. The need stems from the possibility for errors despite checking at either level and the desire of both wholesalers and retailers to protect themselves. However, a 100 percent item check at retail would argue for a sample item check at the warehouse, while a 100 percent item check at the warehouse would make questionable the need for further checking at retail (especially in an integrated warehouse - retail operation and where trucks carry orders for only one or two stores).

sales and in its contribution to the company's profit.

Closely associated with wholesaler-retailer relationship, the size of the order and the delivery schedule affect the choice of a check system. When orders are small, and when deliveries are made once a week, errors in order selection may be more critical for the store than in the case of larger, more frequently delivered orders. In some instances, the warehouse is required to make up the shortages by special deliveries, thereby increasing overall warehouse costs. Thus, a sample item check system is less desirable when the wholesaler serves smaller retailers and delivers smaller orders once a week or less frequently.

The third consideration is the effect of order selection methods on checking speed. Item checking speeds vary from about 400 to 1,000 cases per man-hour, depending on the manner in which the cases selected are placed on selector trucks. When cases are placed on the outer edge of the selector truck only, checking is facilitated; when cases are placed on a pallet on the selector truck and "tied together" for pallet loading onto trucks, checking is slowed considerably. When order selection methods reduce the speed of checking, a sample item check system becomes more advantageous. Table 1 indicates the relative labor cost and error rate of a 100 percent item check against alternative sample item check systems.

A fourth consideration in deciding between 100 percent and sample item check is the selectors' error rate. If the error rate is low (for example, 3 errors or less per thousand cases selected), sample checking is probably adequate; where error rates are 0.4 percent and higher, a sample may permit too many errors in outgoing merchandise (see table 2 for the effect on outgoing error rates of varying selector error rates).

In general, the sample item check seems most advantageous for the larger, integrated operations with relatively low selector error rates. The savings, as indicated in table 1, may be more than 50 percent of the weekly cost of checking by the 100 percent item description system. In a warehouse shipping 100,000 cases a week with a 30 percent sample item check, savings of $200 to $400 would be made weekly, compared with the costs of the 100 percent item check system. The 100 percent item check system probably holds the advantage for the smaller, independent wholesaler-retailer operations where selector error rates may be higher and where errors in outgoing merchandise may be more costly for both the wholesaler and the retailer.

Table 1.--Comparative costs and errors of checking in order selection, based on shipments of 100,000 cases per week with a selector error rate of 50 errors per 10,000 cases checked

Item	Sample check of: 30%	Sample check of: 50%	100% item check
Number of cases checked...	30,000	50,000	100,000
Errors in cases checked...	150	250	500
Total errors found in cases 1/.....	135	225	450 1/
Number of cases not checked:	70,000	50,000	---
Errors in cases not checked:	350	250	---
Total errors (cases) sent out.....	365	275	50 1/
Cost of checking 2/@ $2.50 per hour.....			
400 cases per hour.Dol:	187	312	624
800 cases per hour.Dol:	93	156	312

1/ It is assumed that checkers fail to catch about 10 percent of the errors in the orders assembled and, therefore, there will be 50 errors in 100,000 shipped with a 100 percent item check.

2/ The labor cost of checking (the $2.50 listed includes "fringe benefits) needs to be compared with estimated costs of the errors remaining in the orders when sent out to the stores. These other costs (principally the cost of extra cases sent to the store but not reported) may not be fully known but their magnitude may be estimated. In the independent wholesaler-retailer operation, the overages sent to the stores but not reported may be reckoned at $5 per case and added to the checking cost.

Applying the principles illustrated in table 1, here are two examples of application:

Example A: Using the 50 percent sample check in table 1, there will be about 275 errors in the 100,000 cases shipped. Of these, 124 will be overages and 151 will be shortages. If the stores report all the shortages, but only 50 percent of the overages, the overages will cost the wholesaler $310 (62 cases @ $5). If his labor cost for the 50 percent check is $312, as compared to the $624 for the 100% check, his net checking cost (including labor and merchandise claims) is slightly less under the sample checking system. ($312 + $310 = $622, with sample checking, against $624 + $60 /12 cases at $5 missed by checkers/ = $684 for 100 percent checking.)

Example B: Using the same 50 percent sample check as above, but assuming a selector error rate of 20 cases per 10,000 cases checked (rather than the 50 errors per 10,000 cases used in the table), the comparisons will be as

follows: There will be about 110 errors in the 100,000 cases shipped. Of these, 50 will be overages and 60 shortages. If the stores report all the shortages, but report only 50 percent of the overages, this overage will cost the wholesaler $125 (25 cases @ $5). If his labor cost for the 50 percent check is $312 compared to the $624 for the 100 percent check, his net checking cost (including labor and merchandise claims) is approximately $200 less under the sample checking system. ($312 + $125 = $437 with sample checking, against $625 + $45 /9 cases at $5 missed by checkers/ = $665 for 100 percent checking.)

How a Sample Item Check Works.--A system of sample item checking probably can be adapted to any warehouse selection method. The two principal considerations are: (1) That the checking system fit the physical selection procedure, and therefore not require any special checking efforts nor interfere with the movement of merchandise into delivery trucks; and (2) that each case of merchandise selected during the day have an equal and known chance of being checked for correctness.

Let us assume a warehouse using a selection system in which items are pulled and placed onto a four-wheel handtruck, and the loaded handtruck is pushed onto the loading dock for checking. The copy of the order from which the selection is made is attached to the handtruck by the selector and is thus available to the checker. If every order pulled in this warehouse were confined to one handtruck, a sample item check that would satisfy the two requirements mentioned would be to have every item checked on every second handtruck. This probably would constitute a 50 percent check of all items pulled. While the actual percentage of cases checked would vary somewhat from day to day, the percentage for the total week's selections would be nearly constant.

Let us assume another order selection system with a towline or a radio-controlled tractor with a train of selector trucks. In these warehouses, orders are large, and a single order may be divided among several selectors and each portion of the order that is pulled by a selector may fill three or four handtrucks. Again, the order selector's pull copy is attached to one of the handtrucks in the group he has pulled. Since the cases selected may not be placed on the handtrucks in the same sequence as they appear on the order form, it is more efficient to check the entire group of handtrucks, rather than every second one. To still retain the essential sampling elements, however, every other train of selector trucks or group of handtrucks constituting the selector's work unit may be used as a sampling unit. Again, this would constitute a sample of about 50 percent of the items pulled.

A simple way to select every second group of selector trucks for checking purposes is to use the page or invoice number on the forms from which the selector pulls his order. Odd-numbered invoices may be checked one day, even-numbered invoices on the next

day, and so on. In this way, a 30 or 60 percent check system (as well as a 50 percent system) may be devised: For a 30 percent sample, invoices ending in any 3 numbers, (for example, 1, 5, 9) may be selected for the day; for a 60 percent sample check, 6 numbers may be selected and invoices ending in any one of the 6 numbers would be included in the sample.

Accuracy Control With a Sample Item Check.--A sample item check offers two kinds of control. First, it offers information on how many errors each selector makes and the kind of errors made. Often, one or two selectors consistently make a high proportion of mistakes, and retraining or reassignment makes a substantial difference in the overall error rate for the group of selectors. Knowledge of the kind of error made often indicates the source of error; for example, a pallet in the wrong slot may cause several errors of the same kind, but the error can be caught and corrected by a sample item check. The second form of control is in the knowledge of how many errors there are in the merchandise sent to the stores. A sample item check of about 50 percent of the cases selected will permit warehouse management to know, with a high degree of confidence, that the number of errors in the orders sent to the stores is no greater than the number of errors found in the orders checked. Indeed, since the errors in the checked orders will be corrected, the error rate for all outgoing merchandise will be approximately half of that found in the orders checked (see table 2).

The amount of control over order selection through a sample item check depends on the size of sample (30, 50, 60 percent), the kinds of sampling procedures used (one handtruck or a group of trucks as the sampling unit), and the accuracy of both the selectors and checkers. Table 2 indicates the error rate in outgoing merchandise with varying degrees of accuracy by the selectors, whether the sample unit is based on orders assembled onto one handtruck or onto a group of several handtrucks.

Table 2.--Probable error rate per 10,000 cases in outgoing merchandise under varying levels of order selector accuracy

Selector error rate per 10,000 cases checked	Probable errors in shipments with			
	30% sample	40% sample	50% sample	60% sample
	Number	Number	Number	Number
10 errors	7.3	6.4	5.5	4.6
20 errors	14.6	12.8	11.0	9.2
50 errors	36.5	32.0	27.5	23.0
100 errors	73.0	64.0	55.0	46.0

The estimates given above are based on several assumptions:

A. The error rate is based on a week's shipment of 40,000 or more cases. B. Orders are assembled on a single handtruck with an average of about 30 cases, or on a group of handtrucks with about 120 cases assembled on each group of selector trucks checked, and these groups of cases are the sampling units. C. Checkers fail to catch 10 percent of the errors in the orders they check, but all errors found are corrected before shipment. D. The error rates given above are subject to a sampling error which varies in magnitude with the size of sample and the selector's accuracy. The largest sampling error is in the 30 percent sample with a selector error rate of 100 per 10,000 cases checked; it amounts to $\pm$ 12 errors from the 73.0 errors listed. The smallest sampling error is on the 60 percent sample with a selector error rate of 10 per 10,000 cases checked, and it amounts to $\pm$ 1.5 errors from the 4.6 errors listed.

The following two examples are drawn from error rates shown in table 2:

> Example A. A delivery truck load of 1,000 cases subject to a sampling check of 50 percent (in a warehouse with a selector error rate of 50 errors per 10,000) would have 2.75 errors $\pm$ .06, or not over 3 errors, but not less than 2 errors.
>
> Example B. A delivery truck load of 1,200 cases subject to a sampling check of 40 percent (in a warehouse with a selector error rate of 20 errors per 10,000) would have 1.53 errors (1.28 + .25) $\pm$ .04, or probably not over 2 errors, but not less than 1 error.

Maintaining Records of Selector Errors.--As part of a systematic checking system, it is necessary to maintain records of selector errors. Figure 6 shows a form that can be used for recording order assembly errors by type of error, by order selector, and by store number. By summarizing the daily worksheets onto a weekly summary sheet, and by including information on cases assembled by individual selectors for the week, warehouse management obtains the information necessary for controlling error rates in outgoing merchandise.

Determining Number of Selection Errors.--Every item missing from an assembled order that is in warehouse stock is called a "short" on the order (fig. 6). If 3 cases of one item are missing from the order and the cases are in warehouse stock, the number of errors would be 3 and would be called "short." Merchandise "over" (fig. 6) usually occurs when a selector assembles more cases of an item than are called for on the invoice. For example, when one case of an item is listed on the invoice and the selector assembles two cases, there would be one error of one case of the item "over." When a selector assembles the wrong item, for example, one case of peas instead of one case of corn, two errors

ERRORS IN SELECTION

Checker Name _____

Date _____ Shift _____

STORE NUMBER	INVOICE NUMBER	SELECTOR	MERCHANDISE SHORT		MERCHANDISE OVER	
			Item	Quantity	Item	Quantity

Figure 6.--A form for recording type of selection errors by order selectors, maintained by order checkers.

are charged: The case of peas is one "over," the case of corn is "short." Actually, the checker does not question whether errors are made as a result of substitution, but merely records "shorts" and "overs."

Controlling Damage to Merchandise

Some merchandise is damaged in every grocery warehouse. This damage is associated with the "quality" of the warehouseman's performance, since it is usually caused by poor handling methods, careless operation of materials-handling equipment, or poor stacking methods. Sometimes damage is due to atmospheric conditions, such as very high humidity over extended periods of time.

While the amount of merchandise damaged in the warehouse may not appear great, consideration of the value lost on the basis of sales required to recover the loss places the importance of damaged merchandise in a different perspective. Assuming a gross profit of 5 percent and an average case value of $5, each case of merchandise completely lost through damage requires $100 in sales just to recover the cost. But the cost of damage shows up in other ways that are less tangible. A case of merchandise that is broken open invites pilferage, not only of individual packages, but also generally, if the tone in the warehouse is one of poor housekeeping. Moreover, merchandise which has fallen may obstruct the movement of order selectors and forklift trucks and slow down the overall operation until someone takes the time to set the merchandise aright.

Records of Damage and Causes.--A first step in controlling the amount of damage to merchandise is a record of what is damaged and how the damage occurred. Figure 7 shows a form that can be used to record the quantity of damaged merchandise removed from stock and the reasons for damage. The warehouse damage report should provide space where the supervisor can indicate the person or reasons responsible for the damage. An accumulation of such records and their regular review help management to take action to eliminate the causes of damage and, hence, reduce the losses.

When this form is routed to the tabulating department, commodity cards representing damaged cases removed from active stock can be accumulated and a weekly report can be obtained that will reflect the total value of damaged merchandise removed from active stock. In warehouses using automatic tabulating equipment for inventory control, it is essential to record the quantity of merchandise removed in order to keep actual warehouse inventory and tabulating department inventory records in balance.

Warehouse Damage Report			For week ending _____	
Quantity	Warehouse location	Description: Pack, size, and item code	Damage	Cause of damage
2	4247	XYZ halves peaches 24/303	x	Forklift backed into stack

Figure 7.--A warehouse damage report.

Recouping and Accounting for Damage.--In most warehouses studied, some effort was made to recoup damaged merchandise. If damaged merchandise is recovered and returned to stock, some record is necessary for accounting purposes; figure 8 is an example of a form that can be used for this purpose.

Warehouse Damage Recoup and Credit Report			For week ending _____	
Quantity	Warehouse location	Description: Pack, size, and item code	Return to stock	Credit

Figure 8.--A warehouse damage recoup and credit report.

Many firms have limited the amount of time spent in recouping merchandise by shipping less than full-case quantities to retail stores when a case of merchandise is partially damaged. Invoice adjustments for less-than-case quantities are made by the tabulating department. Others have avoided the cost of recouping by offering salvable merchandise to charitable organizations and recording the amount thus contributed to charity.

MEASURES OF EFFECTIVE PLANT AND EQUIPMENT USE

Just as increases in hourly wages have pointed up the need for effective use of labor, so rising costs and investments in plant and equipment have made it necessary for warehouse management to make optimum use of these resources. This report describes measures of warehouse space utilization, records that will help warehouse management to anticipate warehouse workloads, measures of effective equipment use, and ways of determining whether to install additional equipment.

Warehouse Space Utilization

The quantity of merchandise stored in the warehouse has a direct influence on the productivity of warehousemen. The level of productivity drops when warehouse aisles become cluttered and warehousemen receiving merchandise must make room for the incoming merchandise by repiling and stacking merchandise in the aisles. On the other hand, a warehouse that is only partially utilized has excessive unit costs for rent, heat, and light.

Numerous methods of measuring warehouse space utilization have been tried in the industry. One method used by some firms is to count the number of empty pallets at periodic intervals and correlate the number of empty pallets with the amount of inventory in the warehouse. This system has provided a measure for firms handling groceries only. When groceries and perishables are handled on the same pallets or shipments are made to retail stores or branches on pallets, the pallet count system does not work satisfactorily. Purchases of new pallets and pallet losses from breakage also influence the reliability of this measure.

Another measure of warehouse space utilization used by some firms is a weekly tabulation of the number of empty warehouse slots and the number of items in warehouse aisles. This measure has been helpful in coordinating buying department activities with those at the warehouse. Still another measure of warehouse space utilization is a weekly report of the tonnage or dollar value of warehouse inventory. This measure is usually computed in terms of tonnage or dollar value of inventory per 1,000 square feet of warehouse space. Tonnage per 1,000 square feet of warehouse space is preferred over dollar value because of changing prices. Information on weight is readily available to firms using automatic tabulating equipment, while dollar value would probably be easier to obtain when manual office procedures are used.

Management is interested also in knowing the rate of movement or inventory turnover in the warehouse. Many wholesale food distributors have been able to increase the volume of business done through the warehouse by increasing the rate of inventory turnover. Firms using automatic tabulating equipment in the office

can readily compute the amount of inventory on hand. Inventory turnover is usually computed by totaling the cost of merchandise on hand and dividing the inventory cost into the cost of merchandise sold annually, to obtain the annual rate of inventory turnover. Some firms compute turnover every 4 weeks, based on sales during the 4-week period, and combine 13 4-week periods to compute annual inventory turnover. In firms operating without automatic tabulating equipment, it is usually necessary, periodically, to count the number of cases of each item in the warehouse to develop a reasonably accurate inventory turnover rate.

Management in some firms also requests a report of sales losses because merchandise is out of stock. The percentage of sales loss due to the out-of-stock situation is usually computed daily and used by management as a measure to control the amount of such losses. In these firms, these sales losses are defined in terms of overall sales, and efforts are made to keep the losses within prescribed limits.

The greatest value of reports on warehouse space utilization and inventory turnover has been to acquaint top management and the buying department with the importance of inventory control and the adverse effect of excessive warehouse inventory on operating expense. Sometimes information of this type has resulted in decisions to rent space in other warehouses for storage of surplus seasonal items and quantities of merchandise bought beyond the normal inventory needs of a firm.

Records for Rail Car and Motortruck Receiving

Records have been used by some firms to help organize the receiving operation and to integrate it more effectively with the overall warehouse operation. A record of merchandise in transit to the warehouse and in town is helpful to management in planning warehouse labor and space requirements. Figure 9 shows a form used for a record of rail cars in transit and figure 10 shows a record of rail cars in town.

Records such as those shown in figures 9 and 10 give management information on the status of rail car receiving and the extent to which costs are incurred for demurrage. The reports also show what merchandise is available to the warehouse so management can decide on the sequence in which cars are to be unloaded to meet inventory needs.

Many warehouse operators are concerned about the extent to which delivery truck drivers wait for unloading at their warehouses. These operators recognize that transportation costs for merchandise received by motortruck cover the costs incurred while drivers wait before unloading. Some firms keep records showing the truck arrival time, time that unloading begins, departure time, and quantity of merchandise unloaded.

Record of Cars in Transit — Date - 6/26/59

No.	Car No.	Shipper and Commodity	Routing	Station	Out	Exp. arr.	Destination and stop: Dest.	Destination and stop: Stop	Passings	Weight
1.	DLW 54758	ABC-Tuna -canned:					Chicago	Mpls.		
2.	NP-1296	CDF-Juices					Chicago	Louis-ville		
3.	CNW-7097	JHI-Catsup		Wads-worth	6/20	6/28	Chicago		Toledo 6/22	29,684
12.	ACL-22069	KLM-Cereal Paper					Chicago			
13.	SP-83476	XYZ-Products					Chicago	Milw.		

Figure 9.--A record of rail cars in transit.

Record of Cars in Town — Date - 6/26/59

R.R	Car No.	Shipper	Commodity	Date	A.M. P.M.	Demurrage 1 2 3 4 5 6	Weight	Date unloaded
ABC	NKP-87216	COF	Sugar	6/22	10	F F 3 6 9	65,500	
EFG	ON-21985	HIJ	Salt	6/22	11	F F 3 6 9	48,697	
KLM	RI-23790	M.N.	Cereal	6/24	3	F F	29,122	
XYZ	P.A.530471	ZBO	Fruit	6/26	8		38,000	

Figure 10.--A record of cars in town showing commodity, arrival, demurrage, and weight.

By maintaining and reviewing these records, warehouse management in some firms has been able to reduce the amount of waiting time by rearranging the schedules for incoming merchandise and also by making more truck receiving dock space available. These records have also proved helpful in establishing definite receiving hours in several companies. The receiving hours are usually established so the merchandise can be received and placed in warehouse locations within 8 hours. Records of truck unloading time have been particularly helpful where the dock is used for truck receiving during the day and for shipping during the same or a following shift.

Effective Use of Equipment

A modern warehouse has a large investment in equipment to support and facilitate employees' work. The cost of warehouse equipment and of its maintenance is high and, because of hard usage and rather rapid obsolescence, charges for depreciation also are high. When there is a large investment in equipment, warehouse management must be concerned with the number of hours of effective use and whether additional equipment earns its cost in labor savings.

Meters recording the number of hours of machine operation are frequently put on forklift trucks and other warehouse materials-handling equipment. The meters are used as a gage for determining when preventive maintenance measures need to be performed on the equipment. Meters used in this manner make it possible to obtain more continuous and trouble-free performance from the equipment. Records are maintained also in the equipment repair shop, showing the repairs and maintenance performed on each machine. The records also show the amount of "down" time for each piece of materials-handling equipment, and they are used for determining when replacements are needed.

As business volume expands, many food distributors find it advantageous to add a second shift of warehouse workers. With a second shift, the amount of time that materials-handling equipment is used can often be doubled. Since the equipment depreciates on the basis of age as well as usage, its use for two or even three shifts per day is less costly per hour of use than when the equipment is used for only one shift per day.

Warehouse management is frequently confronted with the question whether to purchase additional materials-handling equipment. The answer requires a realistic appraisal of labor and equipment costs with present work methods, compared with costs for new or additional equipment. A study made by one warehouse operator is described here to illustrate the type of analysis made before materials-handling equipment was purchased.

Management of a modern 125,000-square-foot warehouse was considering the advisability of purchasing tow tractors for use by order selectors. Order selector productivity averaged 110 cases per man-hour with orders assembled on 4-wheel warehouse trucks pushed by hand. A manufacturer lent the company a tow tractor for trial in the warehouse. With the tow tractor, order filler productivity averaged 40 percent more, or 154 cases per man-hour. Table 3 shows a comparison of the cost to assemble 1,000 cases of merchandise with and without tow tractors.

Table 3.--A comparison of cost for the assembly of 1,000 cases with and without tow tractors

Expense item	Without tow tractors	With tow tractors
	Dollars	Dollars
Order assembly labor 1/	20.45	14.61
Tow tractor 2/	---	1.85
Total expenses	20.45	16.46

1/ Assuming a wage rate of $2.25 per hour including fringe benefits.

2/ Bouma, John C. and Lundquist, Arnold L. "Grocery Warehouse Layout and Equipment for Maximum Productivity" U. S. Dept. Agr. Mktg. Res. Rpt. 348, table 5, p. 28. Tow tractor is standup rider-type with 2,000 hours annual usage. Cost includes tractor, battery and charger, depreciation, ownership cost, and operating cost.

A potential saving of $3.99 per 1,000 cases assembled led warehouse management to conclude that tow tractors should be purchased for use by order fillers. Data in table 3 are based on an order filler wage rate of $2.25 per hour. If the tow tractors were used more than 8 hours per day, the hourly cost for use of the machines would be reduced. In using this kind of analysis, it is important to obtain actual productivity with the new equipment, since rated capacity based on speeds of the equipment may not be fully realized in the work situation, and hence the potential savings will not be obtained.

Just as management is concerned with equipment replacement and the addition of new types of equipment, the need for additional equipment also must be evaluated. For example, a firm is faced with the problem of excessive forklift operator overtime to place all merchandise received by motortruck and railroad in warehouse slots. In this firm, merchandise is received during the daytime and is shipped during two night shifts. The forklift truck placed merchandise in warehouse slots during the day, and one forklift operator was assigned to each of the night shifts to

lower needed inaccessible merchandise ahead of order selector calls and to answer order selector calls for letdowns.

It was found that forklift operators on the night shifts were very busy and did not have time to place incoming merchandise in storage. An average of 6 hours of overtime was required daily to place all incoming merchandise in warehouse slots. The 6 hours of overtime were divided among the three daytime forklift operators. A summary of present daily costs and costs with an additional forklift are shown in the following tabulation.

	Labor hours	Labor cost	Equipment cost 4/	Total costs
Present methods	5/ 9	$22.50	$0.65	$23.15
Cost with added forklift	6	15.00	4.58	19.58

As shown in the tabulation, lower costs for labor and lower total costs would be obtained with the addition of another forklift truck and operator. The assumption is made that another forklift would eliminate the overtime man-hours and the operator would be used in other productive work for 2 hours each day.

In some situations, solutions other than the purchase of new equipment may be feasible. For example, in the case previously discussed, other solutions to excessive forklift operator overtime might include assignment of other operators to forklift storage operations during the regular operator's lunch periods, if such operators are available, and also a study of forklift operations with the objective of reducing delays and improving productivity. By such efforts, it might be possible to reduce excessive overtime, thus reducing the advantages of a new machine.

4/ Equipment costs based on Marketing Research Report No. 348, table 5, p. 29 (see footnote 1). With present methods, only equipment operating costs would increase.

5/ Six hours at 1½ times regular wages for overtime, assuming a wage rate of $2.50 per hour including fringe benefits

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